Science Lesson Plan

Kimchi

DATE: 06/13/2012

LESSON TOPIC: How Sound Travels to Your Ear (Longitudinal Waves)

OBJECTIVES/STUDENT LEARNING OUTCOMES:

- Students will be able to label a diagram of the parts of the ear.
- Students will be able to diagram and describe how sound travels from a sound source to the ear.
- Students will be able to justify whether an object makes a sound if there is no sound collector.

GRADE LEVEL INDICATORS:

- PS 6. Describe and summarize observations of the transmission, reflection, and absorption of sound.

MATERIALS NEEDED:

-
- Slinkies
- The Parts of the Ear handouts
- Bowl of water
- Eyedropper of water
- Bowl with saran wrap
- Pepper
- Pan and spoon for making noise
- Markers
- Sound and Energy Handout

INSTRUCTIONAL STRATEGY:

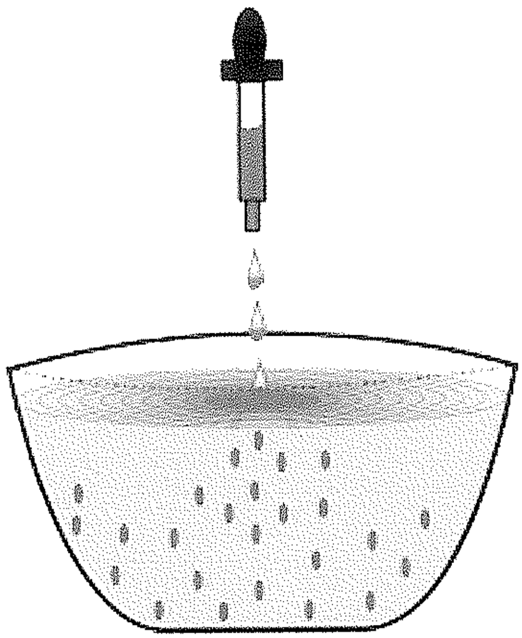
- Whole Class Discussion
- Interactive Demonstration
- Demonstration

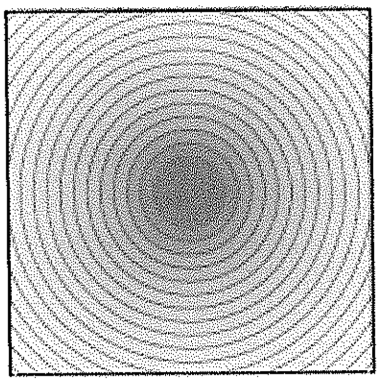
STUDENT GROUPING:

- Whole class
- Individual

TEACHER-STUDENT INTERACTION

- Ask students to write responses to the following question in their NBs: **If a tree falls in the woods, and no one is around to hear it, does it still make a sound?**
- Allow 7 minutes for students to respond.
- Ask 2-3 students to share their responses.
- Who remembers what we learned about the cause of sound? [Vibrating matter causes a sound. You need a vibration in order for there to be a sound. Sometimes you can see and feel sounds because they are made by vibrations]. Today, we are going to look at how sound travels. What evidence do we have that sound can travel or move from one place to the next? [I can hear you from a distance]. How do you think sound gets from one place to the next?"
- Synthesize responses and build on a response that refers to sound waves. Draw an analogy to the **ripples in a pond** when a stone is thrown. Draw an illustration on the board.
    - Place a shallow glass bowl of water on the overhead projector and project the image on the screen. Using the dropper, slowly drop water into the middle of the bowl. Circular waves move away from the point of impact and can be clearly seen.
    - Similarly, sound waves move away from where a sound is produced so that we can hear it. We pretend that the drop of water from the dropper is the source of the sound.

- 



- "These waves look a little different when you look at them from a different angle." Ask students to gather in an open part of the classroom. Use a toy **slinky**. Stretch it out between two students. One student (the "sound source") should grab several coils on the slinky. Then let go. You will see the group of coils go across to the other student ("your ear"). Then come back to the starting student. Make sure students notice how the coils stay together.
- Explain how vibrations cause waves. "We already know that sound is caused by what? [Vibrations]. This demonstration shows how a sound source, which could be a bell or someone talking, makes air particles vibrate. The vibrating object pushes back and forth against the air, like this [move your hands toward and away from you]. When I push on the air, I push air particles together. When I pull back, I don't influence the air particles. This leaves a space in

between the clumps of particles that are close together. If we look at the Slinky, we see this. Sometimes the coils are close together, like when I push at the air. This is called a *compression* [on the overhead, label the lines/ripples in the pond as *compressions*]. We can also see that the coils are far apart sometimes. This is called a *rarefaction*. This is when the molecules are far apart because I am not pushing on them. Scientists have decided to name this kind of wave. They are called *longitudinal waves*."

- Explain how waves travel. "These vibrating particles bump into other ones and make new molecules vibrate. They keep bumping into more particles until the sound has traveled to someone or something that can interpret that sound. People are something that can interpret sound. Later today we will learn how our ears collect sound and send messages to our brains so that we can interpret sounds."
- Tell students to return to their desks.
- On the board write that *Sound travels as a longitudinal wave.* Also write *Each molecule of matter passes the vibrations on to the next molecule*. Draw a picture of a longitudinal wave, originating at a sound source (bell or other vibrating object). Tell students to write the same notes in their Notebooks.
- Have 5-7 volunteers line up between a tuning fork and another student's ear. Students stand an arm's length apart. When the fork is struck, the first students wiggles back and forth and moves toward the second student, who begins wiggling and moving when the first student bumps into him. This continues until the last student "hears" the tuning fork.
- Volunteers return to their seats.
- "When the vibrations reach your ear, what do you think happens?"
- While students answer, distribute Sound and Energy. Give picture of ear on page 61 without labels.
- While you lead the following discussion, label the corresponding parts of the ear. "Your outer ear is like a funnel that collects all of the vibrating air particles. The funnel part is called the *pinna*. This is the part of your ear that you can see. The pinna sends the vibrating air into a tunnel toward your ear. This is called the *ear*

canal. The next part of the ear is called the Middle Ear. The *eardrum* is stretched out over the end of the ear canal, and the vibrating air particles make your eardrum vibrate."

- Do the eardrum demonstration:
  - Shake pepper on the bowl with saran wrap stretched across it.
  - Hit the pan with the spoon, making the pepper jump.
- "This is what happens when sound waves make your eardrum vibrate. Your eardrum is hooked to a very small bone, called the *hammer*. It is called this because some scientists thought that it looks like a hammer. It starts vibrating and hitting a little bone called the *anvil*. The anvil bumps into the last bone of the Middle Ear, which is called the *stirrup*. Some people think this looks like the stirrups on a horse's saddle. The next part of the ear is called the Inner Ear. It is made up of the: (a) *cochlea*, which looks like a snail and changes the vibrations into electrical signals that go to your brain; (b) *auditory nerve*, which carries the electrical message to your brain; and (c) *semicircular canals*, which are three tubes that help you keep your balance." Students should complete their diagrams as well.
- "Based on what we have learned so far, let's reconsider our question: If a tree falls in the woods, and no one is around to hear it, does it still make a sound? [It depends on your definition of sound. If you define sound as a vibration, then it does make a sound. If you define sound as the perception of a vibration, then it does not make a sound because no one detects the sound.]."
- "What evidence do we have to support this? [Sound is caused by vibrations and a falling tree makes the air vibrate. If someone were standing there, his/her eardrum would detect the vibrations and interpret it as a sound]."

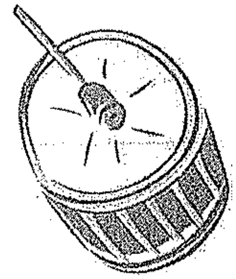
EVALUATING STUDENT LEARNING:

- Students' Ear Diagram handouts are accurately labeled. On the exit slip, they correctly describe the path from the sound source to the ear and brain.

- In their notes and on the exit slips, students make illustrations that accurately represent a longitudinal wave. They include a sound source and a sound-collector. They describe that sound travels as a longitudinal wave.
- during the discussion, students provide scientific evidence to support their responses to the question of whether an object makes a sound if there is no sound collector.

Text Reference: The Need Project Manassas Va. Energy Works pg 59-72

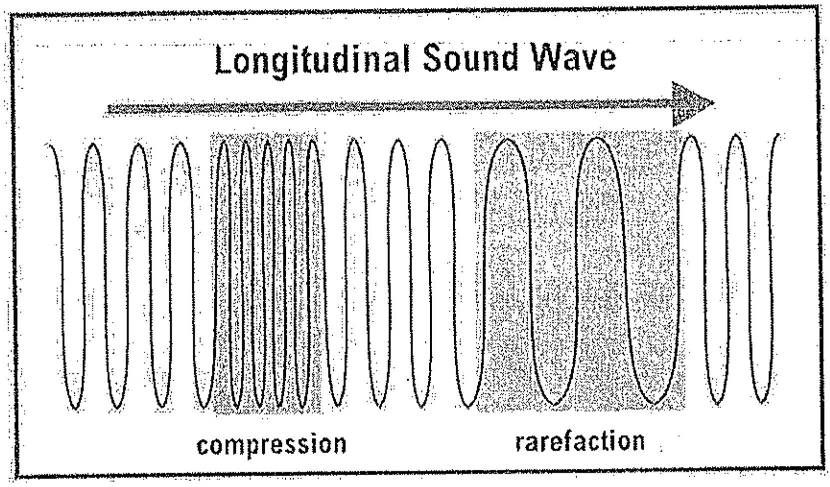
SOUND and ENERGY



Energy is moving around you all the time—energy in the form of sound waves. Sound waves are everywhere. Even on the quietest night you can hear sounds. Close your eyes, hold very still and listen for a moment. How many different sounds can you hear?

SOUND IS ENERGY MOVING IN WAVES

Sound is a special kind of kinetic, or motion, energy. Sound is energy vibrating through substances. All sounds are caused by vibrations—the back and forth motion of molecules. The molecules collide with each other and pass on energy as a moving wave. You can sometimes feel the vibrations of sound. Place your fingers on your throat as you hum.

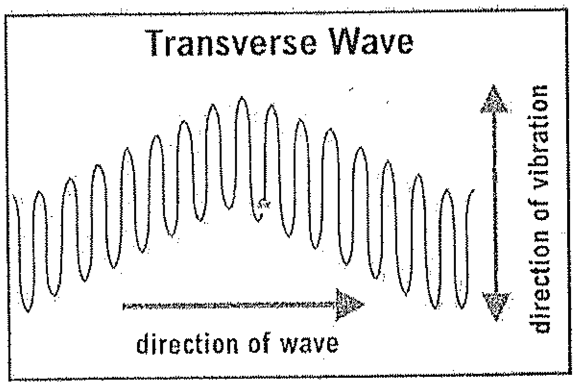


Sound waves can travel through gases, liquids, and solids. The sounds you hear are usually moving through air. When a sound wave moves through air, the air molecules vibrate back and forth in the same direction as the sound. The vibrations push the air molecules close together, then pull them apart. These waves are called **longitudinal** waves. Longitudinal waves move in the same direction as the force making them.

The part of a longitudinal wave in which the molecules are squeezed together is called a **compression**. The molecules are compressed, or squeezed together into a smaller space.

The part of a longitudinal wave in which the molecules are pulled apart is called a **rarefaction**. There are the same number of molecules as in a compression, but they are farther apart.

TRANSVERSE WAVES



Energy also travels in other kinds of waves. When you throw a stone into water, waves of energy move across the surface. The waves move away from the place where the stone hit the water. The water molecules vibrate up and down, at a right angle to the direction of the waves.

A wave in which the molecules vibrate in one direction and the wave of energy moves in another is called a **transverse** wave.

If you've ever been to the ocean, you've probably floated on transverse waves. If you go out beyond the breakers, you can float on the waves without moving closer to shore.

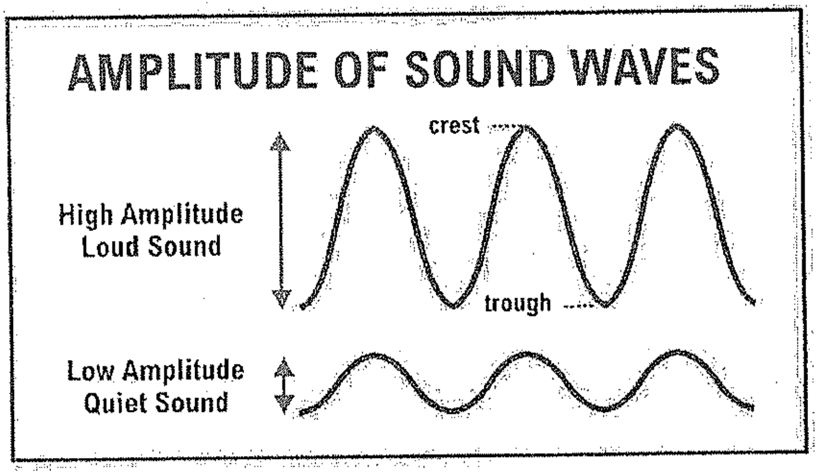
PRODUCING SOUND

Sounds are all around us. Some sounds are made by nature, such as thunder, the roar of the ocean, and wind blowing through trees. Some sounds are made by animals and humans to communicate. Other sounds are just noise—the sounds made by trucks on the highway and big machines. These sounds are by-products of other tasks. As a truck moves down the road, some of its energy turns into vibrations, producing noise.

Humans produce sound by forcing air from our lungs past the vocal cords in our throats. The moving air makes the vocal cords vibrate. By changing the shape of our mouths, the muscle tension on our vocal cords, and the amount of air, humans can make many different sounds. We can change the loudness, as well as the pitch, of the sounds we make. The **pitch** of a sound is how high or low it is.

AMPLITUDE OF SOUND WAVES

The loudness of a sound wave is called its **amplitude**. The amplitude of a wave depends on its size—the height of a wave from its crest to its trough. The **crest** is the highest point of the wave; the **trough** is the lowest point. The louder a sound is, the higher its amplitude. The higher the amplitude of a sound wave, the more energy it has.



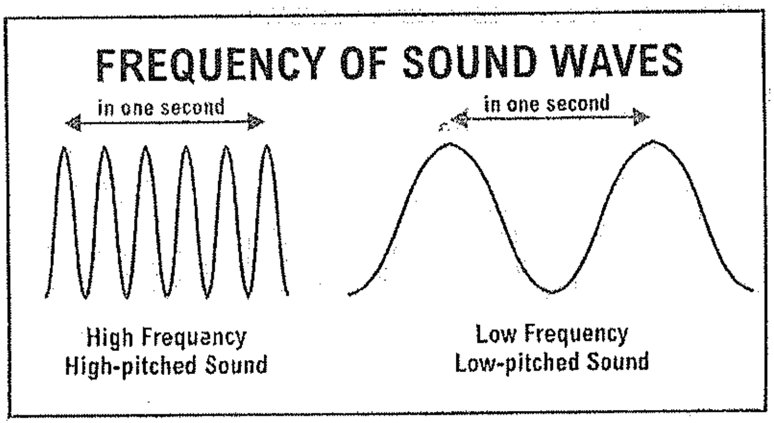
If you turn up the volume on your radio, you increase the amplitude of the sound waves. The frequency of the sound waves remains the same.

If you push more air past your vocal cords, the sound you make will be louder. You will increase the amplitude of the sound. You will put more energy into the sound.

FREQUENCY OF SOUND WAVES

The pitch of a sound depends on the wavelength of its vibrations. The number of wavelengths that pass a point in one second is called the **frequency** of the wave. The more wavelengths, the higher the frequency. Objects that vibrate quickly have a high frequency.

Sound waves with a high frequency produce a high-pitched sound, like a whistle. Sound waves with a low frequency produce a low-pitched sound, like a tuba.

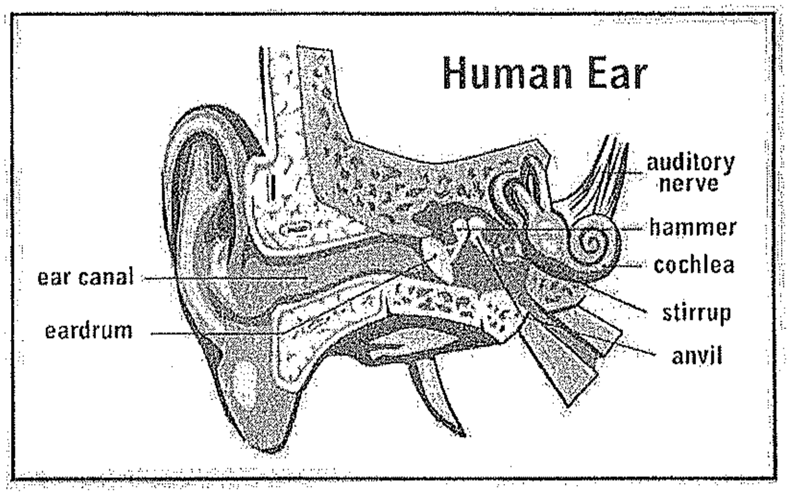


By changing the muscle tension on our vocal cords, we can change the frequency of the sound waves we make. We can change the pitch of the sounds.

HEARING SOUND

Sound waves are all around us. Our ears are amazing organs that change sound waves into electrical signals and send them to our brains. Sound waves enter the ear canal and travel back to the eardrum. The **eardrum** is a thin layer of skin that is stretched tightly over the end of the ear canal, much like the skin of a drum. The sound waves transfer their energy to the eardrum, which begins to vibrate.

As the eardrum vibrates, it moves a tiny bone called the **hammer** back and forth. The hammer moves against the **anvil**—another tiny bone—which vibrates a third bone called the **stirrup**. The stirrup transfers the vibrations to the **cochlea,** which is filled with liquid and lined with hundreds of tiny hairs. The hairs vibrate, sending signals to the auditory nerve, which carries the signals to the brain.

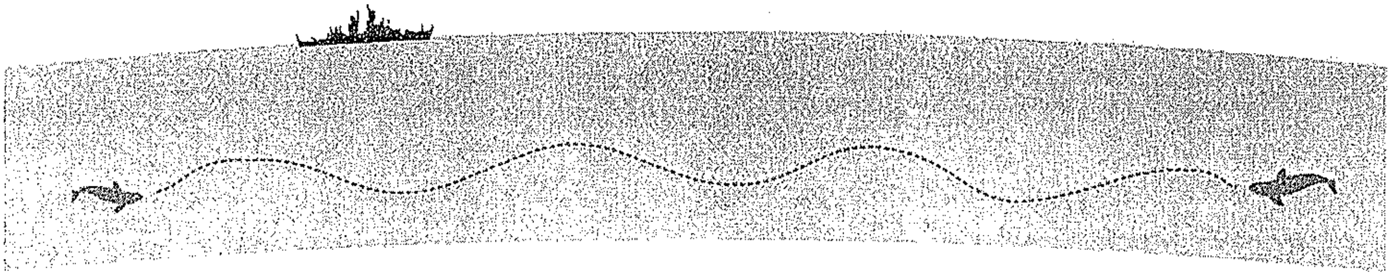


Our brains can also tell the direction of the sound by differences in the amplitude of the sound and when it reaches the ear. A sound on the left, for example, will reach the left eardrum before it reaches the right one. It will also be louder on the left than on the right.

SOUND CAN MOVE THROUGH LIQUIDS AND SOLIDS

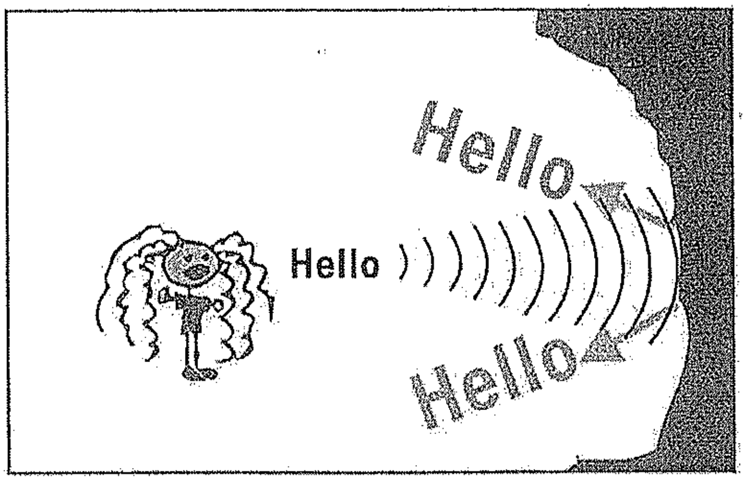
Sound travels faster and farther through liquids than through air. The molecules of liquids are closer together than the molecules of gases. It is easier for energy to move from one molecule to another when the molecules are close together. Sound travels best in solids because the molecules are so close together. Sound travels about five times faster in water than in air, and almost 20 times faster in steel. In air, sound travels at 1,130 feet per second (343 meters per second). It takes almost five seconds for sound to travel one mile. In water, it only takes about one second for sound to travel a mile.

Whales and dolphins use sound to navigate and communicate with each other. Scientists believe whales sing songs underwater that are heard by other whales hundreds of miles away. The builders of the underwater tunnel between England and France communicated by tapping signals on the steel tunnel. The signals traveled quickly to the other end of the tunnel.

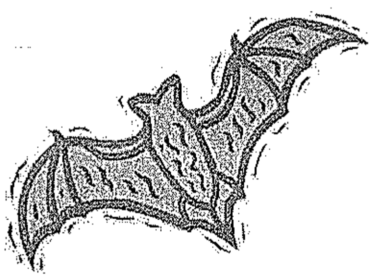


THE MOVEMENT OF SOUND WAVES

Sound waves move through air in a straight line. When they reach an object, they can be reflected or absorbed by the object. You have heard reflected sound waves as **echoes**.



Hard objects usually reflect sound waves. If you yell into a cave, the sound waves will bounce off the walls and produce echoes. Since the walls are not flat, the sound waves will scatter, bouncing in many directions.



Bats are blind, but they use sound waves to fly without bumping into things. They make sounds that bounce off objects. The bats can tell where the objects are by listening to the reflected sounds. Their hearing is so good that they can find the insects they eat using sound waves.

Soft objects usually absorb sound waves. People often use carpets and curtains to absorb sound waves in houses. The insides of cars are covered with soft materials to absorb noise, too.

MEASURING SOUND

We can measure sound in different ways. We can measure the frequency of a sound—the number of wavelengths that pass a point in one second. Frequency is measured in Hertz (Hz). One **Hertz** is equal to one vibration per second. An object that vibrates 100 times a second has a frequency of 100 Hz. Humans can hear sounds with frequencies from 20–20,000 Hz. The frequency of normal conversation is about 1,000 Hz, but we can make sounds from about 50 to 10,000 Hz. A dog can hear frequencies as high as 50,000 Hz, and a bat can hear frequencies up to 120,000 Hz.

We can also measure the amplitude of sound—how loud it is. The amplitude depends on the amount of energy a sound wave has. The **decibel** (dB) is used to measure the amplitude of sound.

The decibel scale is a multiplier scale. For every 10 decibels that are added to the sound level, the loudness is multiplied by 10. This means that increasing the sound by 20 decibels multiplies the loudness by 10 x 10 = 100 times.

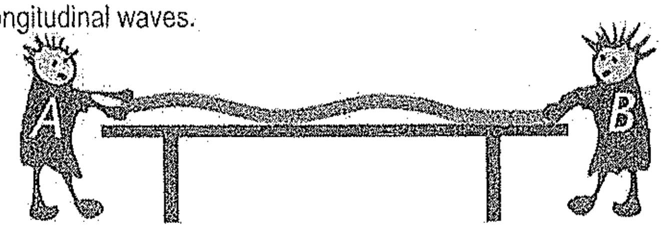
Zero on the decibel scale is the smallest sound that can be heard by humans. At 130 decibels, the sound level becomes painful and can damage human ears. For people working in noisy places, the sound level should not exceed 90 decibels.

Decibel Scale

0 dB	minimum human hearing
20 dB	falling leaves
30 dB	whisper
50 dB	inside an urban house
60 dB	normal conversation
90 dB	heavy traffic
100 dB	loud shout
117 dB	loud rock concert
130 dB	human pain threshold

EXPLORING SOUND 1

PURPOSE: To explore the movement of transverse and longitudinal waves.



MATERIALS: 1 Slinky spring
1 8' long table*

HYPOTHESIS: Read the procedure.
Record what you think will happen.

PROCEDURE:

1. Students A & B: Stand at opposite ends of the table, each holding one end of the spring.

2. Student B: Hold the spring on the table, so that your end of the spring doesn't move.

3. Student A: Slowly move the spring up and down about 4". Observe the motion of the spring. Move the spring more quickly, keeping the size of your motion the same. Observe the motion of the spring. Increase the height of the motion to 8". Begin slowly, then increase the speed of your motion until it is very fast. Observe the motion of the spring.

4. Student A: Hold the spring on the table, so that your end of the spring doesn't move.

5. Student B: Push and pull the end of the spring forward and backward on the table top about 6" toward Student A. Begin slowly, then increase the speed of your motion. Observe the motion of the spring. Increase the length of your movement to 12". Begin slowly, then increase the speed of your motion until it is very fast. Observe the motion of the spring.

DATA: Record your observations.

CONCLUSIONS: In Steps 1-3, a transverse wave was produced. Energy was added in an up and down motion or vibration, but the movement of the wave was horizontal. The vibration was at right angles to the wave.

How does increasing the speed of a vibration affect a transverse wave? How does increasing the size of a vibration affect a transverse wave?

In Steps 4-5, a longitudinal wave was produced. Energy was added in a back and motion or vibration, in the same direction as the wave. Could you see the compressions and rarefactions of the wave?

How does increasing the speed of a vibration affect a longitudinal wave? How does increasing the size of a vibration affect a longitudinal wave?